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National Automotive Center (NAC) Overview & Green Technology Initiatives

Visit by Agency for Defense Development, South Korea

Mr. Paul F. Skalny, Director, National Automotive Center

Report Documentation Page

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Mission:The Center will serve as the Army focal pointfor the development of dual-use automotive technologiesand their application to military ground vehicles. It will focus on facilitating joint efforts between industry, government and academiain basic research, collaboration, technology, industrial base development and professional development.?

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TARDEC National Automotive Center (NAC)

Chartered by Secretary of the Army 21 June 1993

Mission: "The Center will serve as the Army focal point for the development of dual-use automotive technologies and their application to military ground vehicles. It will focus on facilitating joint efforts between industry, government and academia in basic research, collaboration, technology, industrial base development and professional development."

"Leveraging Opportunities to Fill Technology Gaps."

"Accelerating the infusion of commercially viable technology into military land warfare systems"

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Army Energy Security Goals

Strategic Energy Security Goals (ESGs)

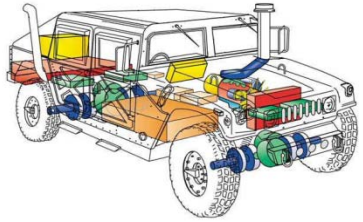
ESG 1: Reduced energy consumption.

ESG 2: Ensuring resilience in energy systems.

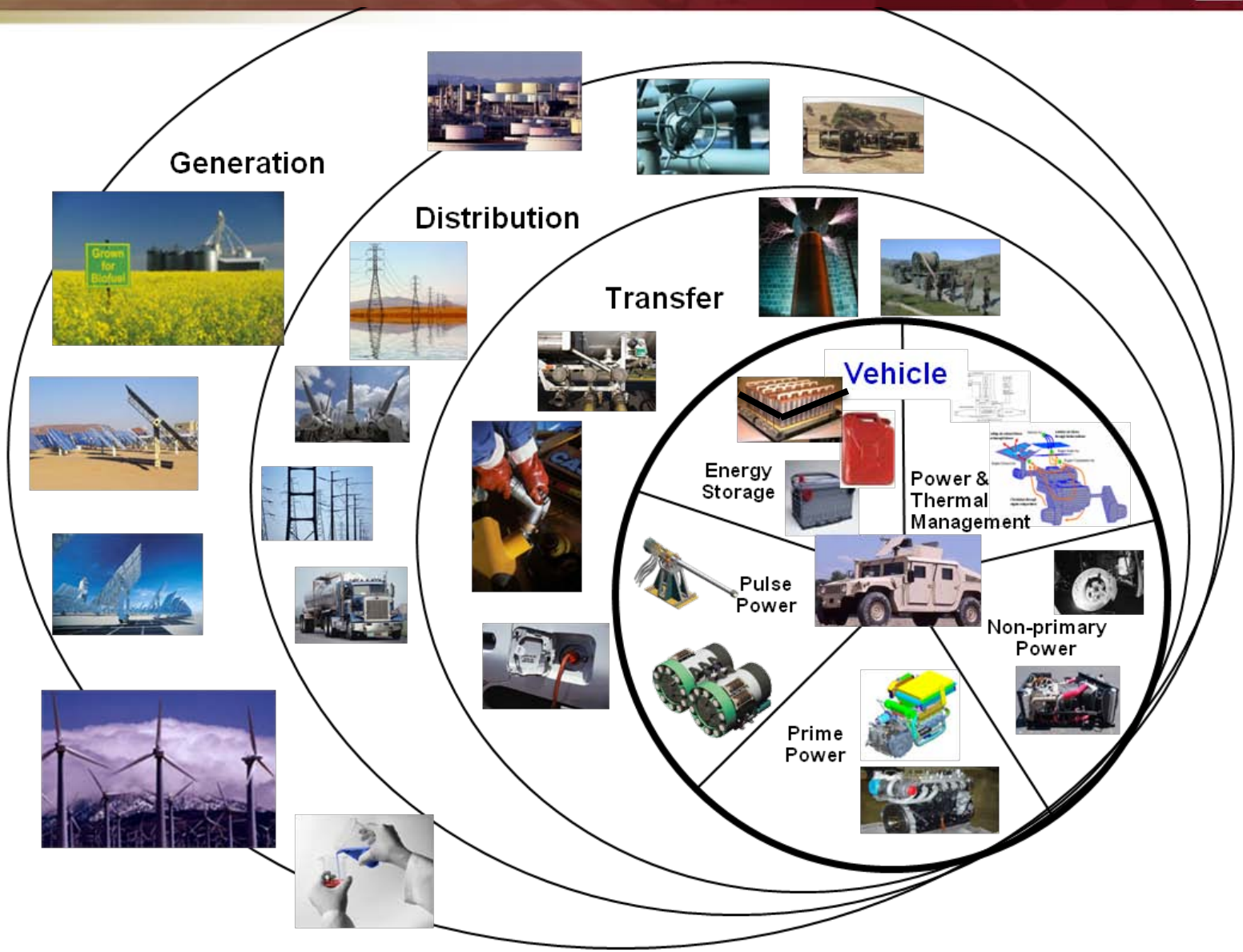
ESG 3: Increased use of renewable/alternative energy.

ESG 4: Assured access to sufficient energy supplies.

ESG 5: Reduced adverse impacts on the environment.



TARDEC's End-to-End Energy Business: From Generation to Application



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Plug-in Hybrid Electric Vehicle with V2G

Developmental Platforms

Commerical Product Conversion

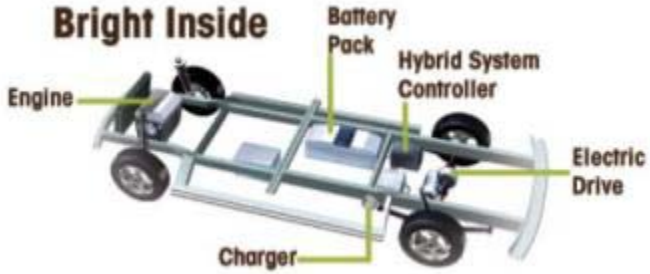
- PHEV conversion for this program
- Modeled in Task 1 Simulations
- Testing of actual conversion used to refine simulations

Commerical PHEV

- Currently a concept prototype (CP1)
- Modeled in Task 1 Simulations
- Updated model based on refined simulations

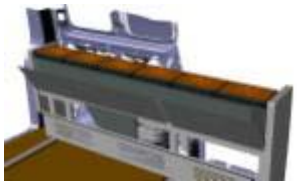
Powertrain Architecture

- Parallel thru the road Hybrid architecture for transport vehicles
- Vehicle to Grid (V2G) capability



Battery Pack

- 10.6 kWh battery using iron phosphate prismatic cells
- 24 cells (14.5 ahr each) per module that are electrically connected in series
- Ten modules in (10S 1P) arrangement to create the vehicle battery pack



V2G Capability

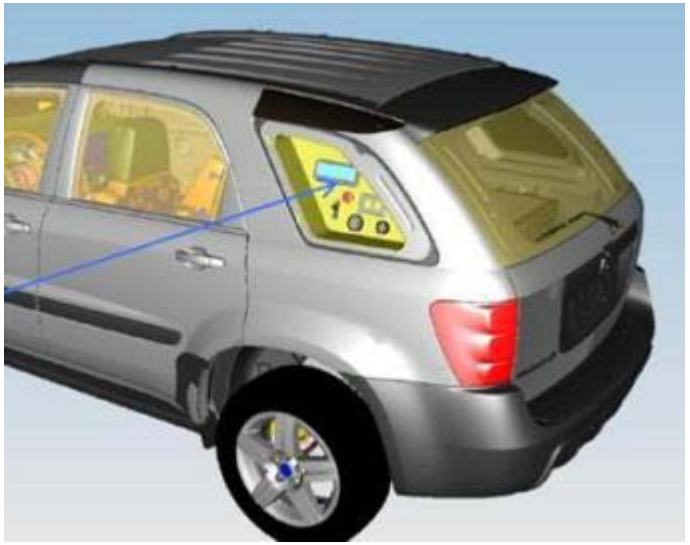
- Standby power has been demonstrated using various loads.
- Grid tie capability has been demonstrated through bi – directional connection to a 240v outlet.

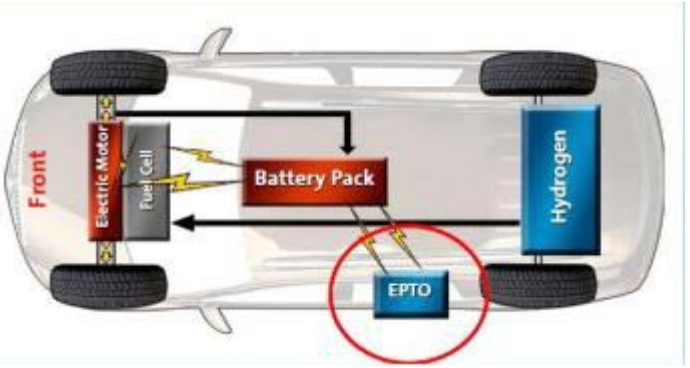
Vehicle to Grid Demonstration

Fuel Cell Vehicle Electric Power Take Off

GMT101X EPTO Demonstration Output Specifications:

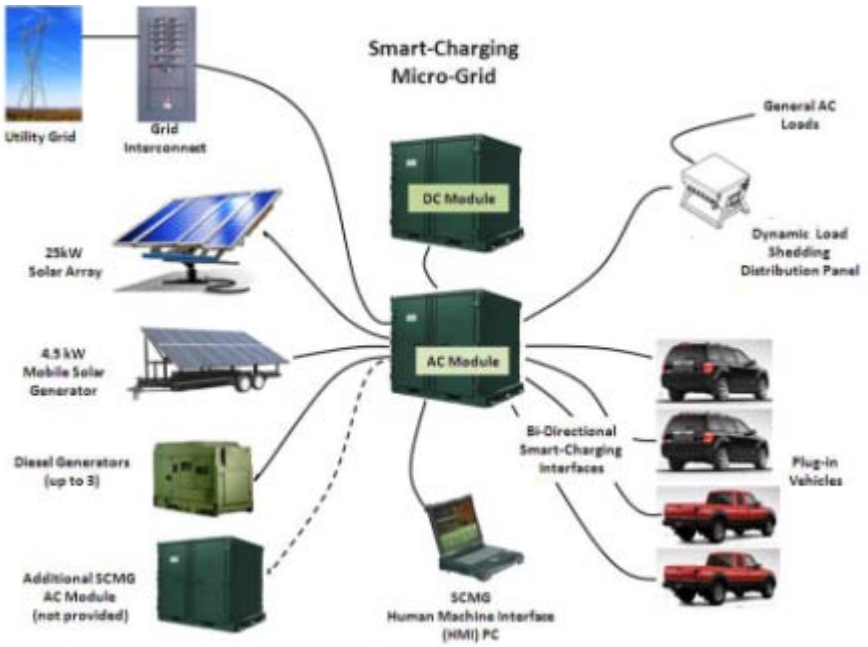
- Outputs are intended to simulate common household/industrial 120/240Vac power
- Outputs specifications:
  - 120Vac @ 15 Amps RMS
  - 120 / 240Vac @ 50 Amps RMS
  - 240Vac @ 100 Amps RMS
- Power
  - Continuous total load 25kW Max
  - Peak total load 40kW max for 0.5 sec
- GM working with Honeywell on linking the FCV-EPTO to their microgrid





Smart-Charging Micro-Grid

- **Installation of microgrid at Schofield Barracks, tied to critical infrastructure**
  - Photovoltaic array
  - Dedicated electric vehicle charging
  - Grid connected
  - Conventional generator for extended backup power
  - Advanced stationary energy storage
  - Load management
- **AC architecture**
- **Microgrid scheduled to be operational in November 2010**
- **Data collection and operational support for one year**

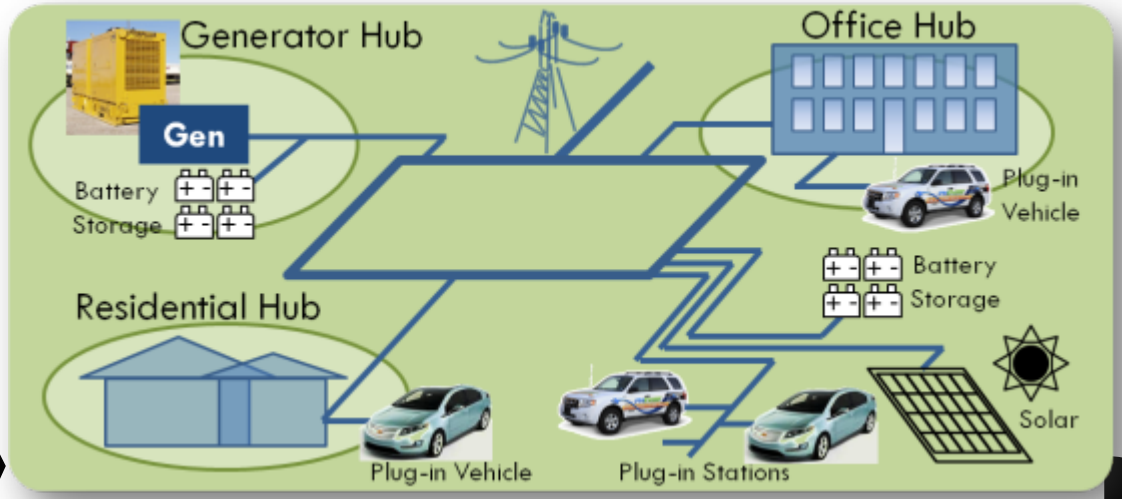


Modeling, Design, and Control of Military V2G V2G Micro-Grid Systems

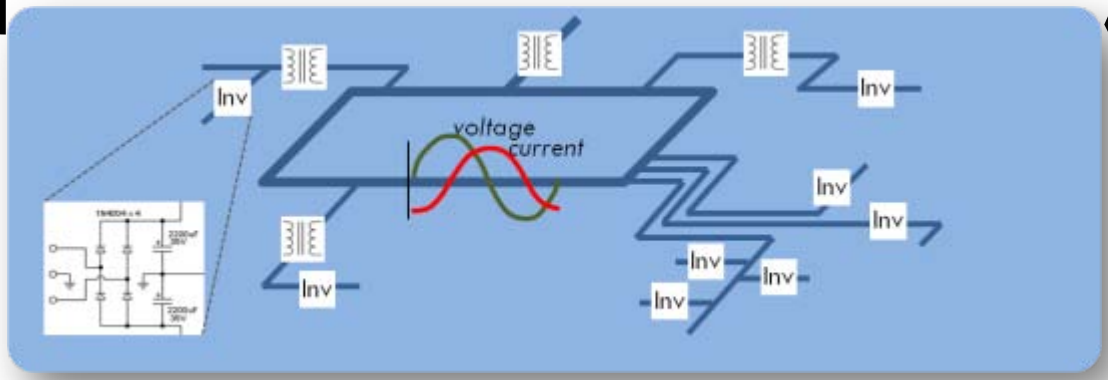
Decide the optimal number, size, and scheduling of microgrid components (generation, storage) and number and scheduling of vehicles to support the electrical loads of the base.

- There is recent research on optimal sizing of microgrids and optimal scheduling of microgrids, as well as V2G control
- Combined design and scheduling has not been studied
- Addition of random vehicle behavior has not been studied, nor potential to control vehicle connection/disconnection from microgrid

Design & Scheduling: centralized control, long time scales



[system stability & transient effects] *[system design & operation]*



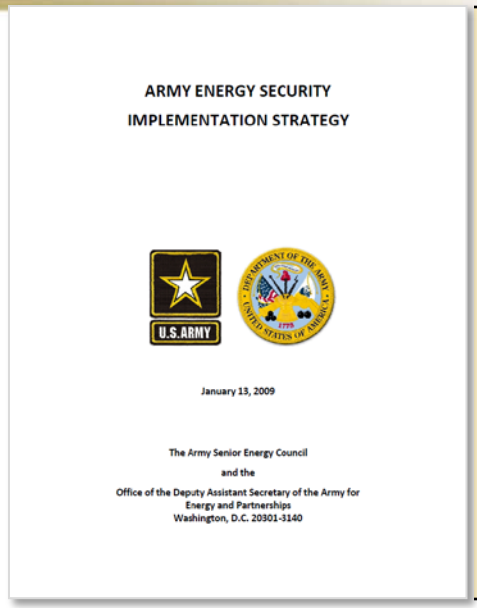
Regulation: decentralized control, short time scales

TARDEC Hybrid Truck Users Forum (HTUF)

- 10 year, Army (TARDEC) funded, contractor managed program
- Major fleet users, all truck makers and suppliers involved\
- Harmonized needs – aggregated demand
- Has spurred:
  - rapid, early demonstration and production
  - expanded hybrid manufacturing capability
  - seeded military needs in commercial designs
  - cost-effectively validated system performance

Reduced Commercialization - 2 years

Army Energy Strategy Plan (Fuels Related)

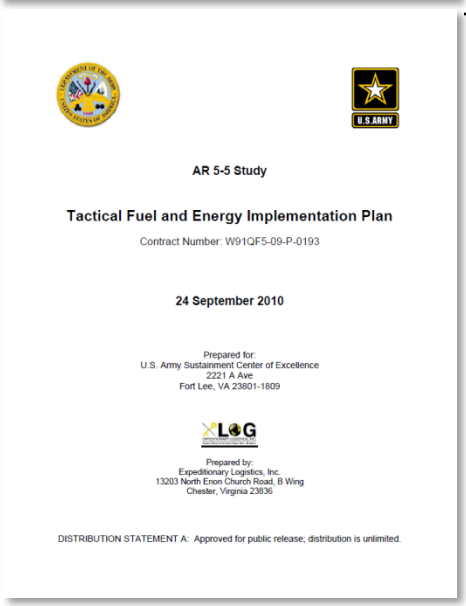


ARMY ENERGY SECURITY
IMPLEMENTATION STRATEGY

U.S.ARMY

January 13, 2009

The Army Senior Energy Council
and the
Office of the Deputy Assistant Secretary of the Army for
Energy and Partnerships
Washington, D.C. 20301-3140



U.S.ARMY

AR 5-5 Study

Tactical Fuel and Energy Implementation Plan

Contract Number: W91QF5-09-P-0193

24 September 2010

Prepared for:
U.S. Army Sustainment Center of Excellence
2221 A Ave
Fort Lee, VA 23801-1809

Prepared by:
Expeditionary Logistics, Inc.
13203 North Enon Church Road, B Wing
Chester, Virginia 23836

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Strategic Energy Security Goal 3

Increased Use of Renewable / Alternative Energy

Objective 3.3

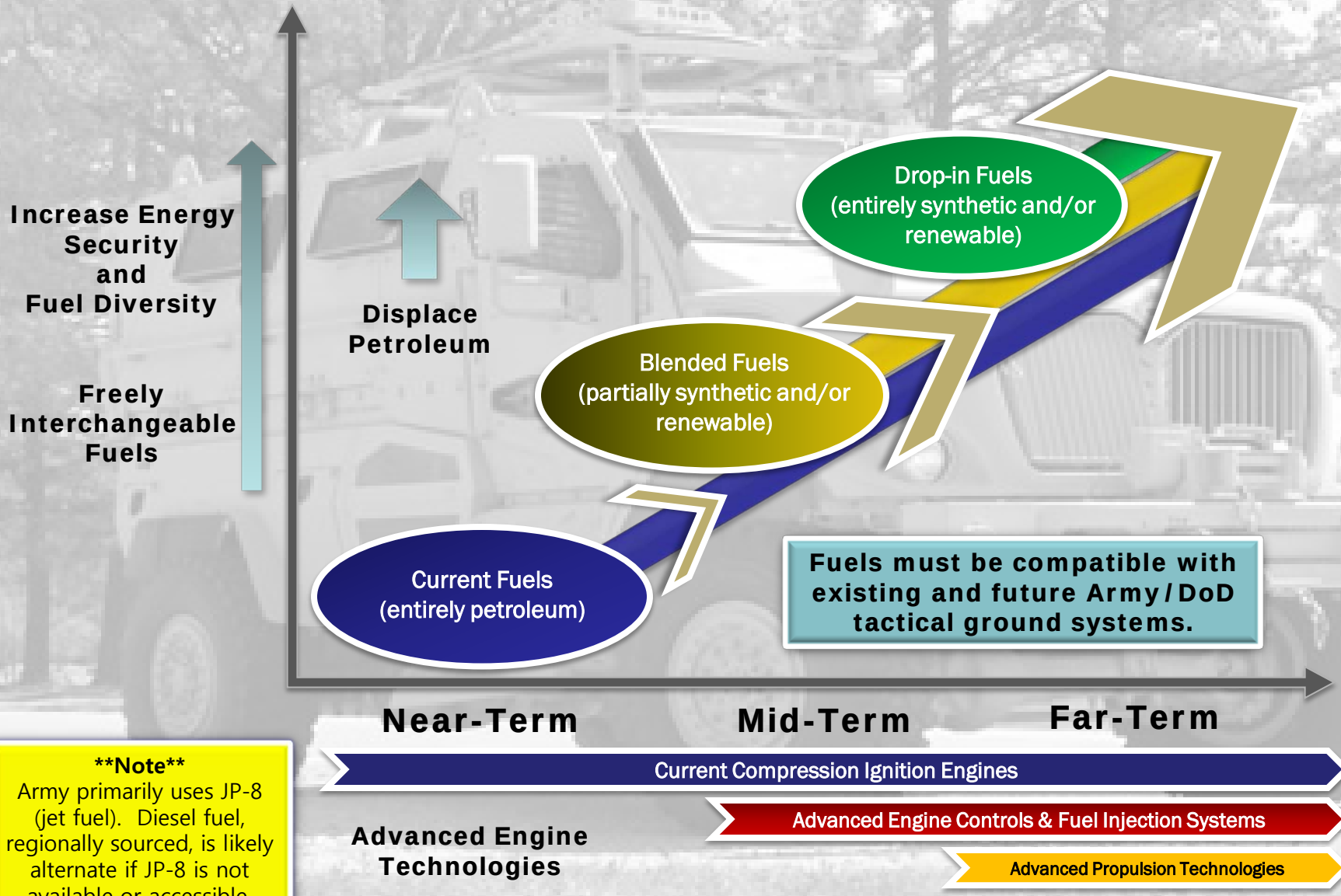
Transition from fossil fuel based tactical mobility/power generation to renewable and alternative energy/sources.

By 2028, 50% of the fuel requirement in the training base for the tactical mobility fleet (surface and air) is met by alternative fuel blends.

- Intended outcomes focused on integrating the use of alternative fuels in vehicle and aircraft engines in the training base
- Percent of fuel requirement met by alternative fuel blends:

15% by FY18
30% by FY23
50% by FY28

Army Bulk Fuel Roadmap



Note
Army primarily uses JP-8 (jet fuel). Diesel fuel, regionally sourced, is likely alternate if JP-8 is not available or accessible.

Paving The Way For Increased Use Of Alternative Fuels

EMERGING ALTERNATIVE FUELS MARKET

- DOD
- DOE
- Industry
- Academia
- Fuel Producers
- Equipment OEMs
- Other Government Agencies
- Standards Development Organizations

Market Connection

- Fuels: process technology, data, test volumes
- Engines: combustion/fuel injection technology
- Market: regulations, policies, initiatives

Develop fuel specifications and qualify new fuels to ensure their suitability for use in ground equipment.

Develop engines more adaptable to changes in fuel quality/supply.

Fuel / Component Evaluations

- Chemical composition
- Physical properties
- Component performance / durability

Engine Evaluations

- Fuel ignitability
- Fuel combustion
- Performance / durability

System Evaluations

- Operability
- Performance
- Demonstrations

Fuel Qualification Process for approval of new fuels

Wayne State University Photo courtesy of N. A. Henein, WSU

Self-adjusting engine operation with changes in fuel quality to maintain desired engine performance

Acceptance of alternative fuels for use in ground vehicles/equipment.

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BACK-UPS

Alternatives to JP-8 in Advanced Evaluation

- Two alternative fuels for which evaluations are being completed to assess their impacts on tactical ground systems
  - Blends of JP-8 and up to 50% by volume of
    - Fischer-Tropsch Synthetic Paraffinic Kerosene (FT SPK)
    - Hydroprocessed Renewable Jet (HRJ)
  - Both products (FT SPK and HRJ) are very similar compositionally
    - Resultant properties are very similar
    - Evaluations thus conducted using one of these blends will be representative of evaluations for the other by similarity
  - Evaluations are conducted using nominal 50%:50% volumetric blends
  - Blends are meant to be "drop-in" fuels
    - Meets fuel performance requirements (in spec)
    - Requires no change to vehicles/equipment
    - Requires no change to infrastructure
    - Can be mixed or alternated with petroleum-derived fuel

Alternatively Sourced Liquid Hydrocarbons

Biomass Feedstock (renewables)

Fossil Energy Feedstock (large U.S. resource)

Petroleum Crude Oil

(increasingly difficult discovery and unfriendly-nation production)

- Various conversion processes dependent on feedstock
- Product meeting commercial and/or military specifications
- Specs evolving to address alternatively sourced hydrocarbons

Jet Fuel

- ASTM D1655: conventional jet fuel
- ASTM D7566: blends of synthetic kerosene with conv. jet fuel
- MIL-DTL-83133: JP-8, also blends of synthetic kerosene with JP-8

Diesel Fuel

- ASTM D975: up to 5% v. FAME biodiesel (B100) allowed in diesel fuel
- ASTM D6751: B100 spec
- ASTM D7467: blends of 6%-20% v. FAME biodiesel (B100) with diesel